MCP361: Assignment 4

Sanchit | 2021ME21063

1 Introduction

The Bill of Materials (BOM) explosion process is used in manufacturing and inventory management to determine the net requirements of components needed to fulfill the demand for end products. This document explains the BOM structure, the format used for inputs, and the calculations performed in the Python code provided.

2 BOM Structure and Format

2.1 Generic Format

To handle BOM dependencies and inputs in a generic way, the following format is used:

- **BOM Structure**:
  - `Dictionary`: Maps each item to its components and their quantities.
  - Example:

```
bom_structure = {
    'A': {'B': 1, 'C': 2},
    'B': {'C': 1},
    'C': {}
}
```

- **Inputs**:
  - **Demand**: A dictionary specifying the demand for each item over time periods.

```
demand = {
    'A': [15, 20, 30, 10, 30, 30, 30, 30],
    'B': [0]*8,
    'C': [0]*8
}
```

- **Available Inventory**: A dictionary mapping each item to its on-hand inventory.

```
inventory = {
    'A': 30,
    'B': 60,
    'C': 60
}
```

- **Scheduled Receipts**: A dictionary mapping each item to a list of scheduled receipts due over time periods.

```
scheduled_receipts = {
    'A': [20, 10],
    'B': [10],
    'C': [20, 10]
}
```

2.2 Usage

The code initializes inventory and receipts, calculates net requirements for each item, and propagates demand according to the BOM structure. It dynamically handles dependencies and calculates requirements based on the input format.

3 Additional Calculations for Non-zero Lead Time and Non-lot-for-Lot Production Policy

When the assumptions of a lot-for-lot production policy and zero lead time are not satisfied, two additional quantities must be calculated to ensure accurate planning and inventory management:

3.1 Order Quantity Calculation

Why Calculate EOQ? If a lot-for-lot production policy is not used, it is essential to determine the optimal order quantity to minimize total inventory costs, which include ordering costs and holding costs. The Economic Order Quantity (EOQ) is used to determine the optimal size of each order, balancing these costs effectively.

Formula:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Where:

- D is the annual demand for the item.
- S is the setup or ordering cost per order.
- H is the holding cost per unit per year.

This formula helps in calculating how much to order each time to minimize the sum of ordering and holding costs.

3.2 Lead Time Calculation

Why Calculate Lead Time? If the production or procurement process has a lead time (the time required to produce or receive goods after placing an order), it is crucial to adjust the ordering schedule to account for this delay. The lead time ensures that materials are available when needed, preventing stockouts or production delays.

Formula:

$$Lead\,Time = \frac{Order\,Quantity}{Production\,Rate}$$

Where:

- $Order\,Quantity$ is the quantity of items ordered.
- $Production\,Rate$ is the rate at which items are produced or received.

Calculating lead time helps determine when to place an order so that inventory levels align with the demand forecast and production schedule.

Summary These calculations ensure that inventory management is optimized, even when the basic assumptions of lot-for-lot production and zero lead time are not met. EOQ helps in managing the costs associated with ordering and holding inventory, while lead time calculations ensure timely availability of materials for production. Without these calculations, inventory planning may lead to either excessive stock or shortages, impacting operational efficiency and costs.

4 Manual Calculation and Verification

4.1 Manual Calculations for Item A

Week	Demand	Scheduled Receipts	On-Hand Inventory	Net Requirement
0	-	-	30	-
1	15	20	15	0
2	20	10	25	0
3	30	0	-5	5
4	10	0	-	10
5	30	0	-	30
6	30	0	-	30
7	30	0	-	30
8	30	0	-	30

4.2 Manual Calculations for Item B

Week	Demand	Scheduled Receipts	On-Hand Inventory	Net Requirement
0	-	-	60	-
1	0	10	60	0
2	0	0	60	0
3	5	0	55	0
4	10	0	45	0
5	30	0	15	0
6	30	0	-5	5
7	30	0	-	30
8	30	0	-	30

Demand for Item B = 1 * Net Requirements of Item A

4.3 Manual Calculations for Item C

Week	Demand	Scheduled Receipts	On-Hand Inventory	Net Requirement
0	-	-	60	-
1	0	20	60	0
2	0	10	60	0
3	10	0	50	0
4	20	0	30	0
5	60	0	0	0
6	65	0	-65	65
7	90	0	-	90
8	90	0	-	90

Demand for Item C = 2 * Net Requirements of Item A + 1 * Net Requirements of Item B
The corresponding answers for Net Requirements of A, B, and C match exactly as produced by our code:

- **Net Requirements:**
  - **A** = [0, 0, 5, 10, 30, 30, 30, 30]
  - **B** = [0, 0, 0, 0, 0, 5, 30, 30]
  - **C** = [0, 0, 0, 0, 0, 65, 90, 90]